09/720 259
1733

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 09 April 2001 (09.04.01)	
International application No. PCT/NO00/00157	**Applicant's or agent's file reference** Opti45PCT
International filing date (day/month/year) 12 May 2000 (12.05.00)	**Priority date** (day/month/year) 12 May 1999 (12.05.99)
Applicant INGANÄS, Olle et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

12 December 2000 (12.12.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Claudio Borton
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 00/00157

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G03F 7/00, B41M 1/06, B81C 1/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B41M, B81C, G03F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

QUESTEL: EDOC, WPIL, JAPIO DIALOG: DIALINDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5512131 A (AMIT KUMAR ET AL), 30 April 1996 (30.04.96), column 5, line 62 - column 6, line 14; column 11, line 22 - line 62, figure 1a ---	14-16
A	US 5358604 A (CHARLES W.C. LIN ET AL), 25 October 1994 (25.10.94), column 7, line 11 - column 8, line 9, figures 1-6 --- --------	14-25

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 August 2000	16 -08- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Bengt Christensson/MN Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
NO0000157

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).:

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See next page

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO99/00157

I Claims 1-13 describe a method for patterning a polymer film. A stamp is applied to the polymer. Portions of the polymer film are removed with the stamp.

II Claims 14-25 describe a method for transferring a patterned polymer film onto a material surface by means of a stamp.

The "special technical features" in each group of claims are as a whole different form each other. Therefore, these groups of inventions are not so linked together as to form a single inventive concept with regard to PCT Rule 13.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/NO 00/00157

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5512131 A	30/04/96	US 5900160 A	04/05/99
US 5358604 A	25/10/94	NONE	

PATENTSTYRET
Styret for det industrielle rettsvern

NORSK GRANSKINGSRAPPORT Patentsøknad nr. 1999 2295
NORWEGIAN SEARCH REPORT Patent application no.

Kategori/ Category*	Anførte publikasjoner: Cited documents:	Relevant mot krav Relevant to claim(s)
X, D	**US 5512131 A (KUMAR, A, WHITESIDES, G. M.) 30. APRIL 1996** (Sammendrag, kol. 2 linje 24-57, kol.3 linje 7- 20, 55-65, kol. 4 linje 24-35, kol. 5 linje 62- kol. 6 linje 15, kol 10 linje 40-51, kol. 11 linje 9- kol. 12 linje 53, krav 1,fig. 1a)	1
X	**RD 419100 A (INT. BUSINESS MACHINES CORP) 20. FEBRUAR 1999** (Hele)	1, 14
A	**GUPTA, V. K. ET AL. DESIGN OF SURFACES FOR PATTERNED ALIGNMENT OF LIQUID CRYSTALS ON PLANAR AND CURVED SUBSTRATES. SCIENCE. JUNI 1997, VOL. 276 5318 PP. 1533-1536, ISSN 0036-8075** (Kol. 2 side 1533-kol. 2 s 1534)	14
A	**AKSAY, I. A. ET AL. BIOMIMETIC PATHWAYS FOR ASSEMBLING INORGANIC THIN FILMS. SCIENCE. AUGUST 1996, VOL. 273 5277 PP. 892-897, ISSN 0036-8075.** (Kol. 2 siste avsnitt side 893 - 2. avsnitt kol. 1 side 894)	14
A	**Zhao, X-M. 'Microfabrication using soft lithography (waveguides, self assembled monolayers, surface defects, shrinkable polystyrene, etching)', 1998, Vol. 59/10-B of dissertation abstracts international side 5538. 234 sider. (sammendrag) Dissertation Abstracts Onlineä [online]. Bell & Howell Information and Learning, 300 North Zeeb Road, Ann Arbor, MI 48103 [fremtrukket den 10. mai 2000]. Hentet fra: Dialog Information Services, Palo Alto, CA, USA. Dissertation Abstracts Online™ Accession no. 01674045.**	14
A	**Xia, Y. 'Soft lithography: Micro- and nanofabrication based on microcontact printing and replica molding'. 1996, Vol. 57/10-B of dissertation abstracts international side 5538. 307 sider. (sammendrag) Dissertation Abstracts Onlineä [online]. Bell & Howell Information and Learning, 300 North Zeeb Road, Ann Arbor, MI**	14

PATENTSTYRET
Styret for det industrielle rettsvern

48103 [fremtrukket den 10. mai 2000]. Hentet fra: Dialog Information Services, Palo Alto, CA, USA. Dissertation Abstracts Online™ Accession no. 01536487.

*Dokumentkategori:		*Category of cited document:	
X:	særlig relevant alene	X:	particularly relevant if taken alone
Y:	særlig relevant dersom det kombineres med annet dokument i samme kategori	Y:	particularly relevant if combined with another document of the same category
A:	bakgrunnsteknikk	A:	technological background
D:	anført i beskrivelsen	D:	document cited in the application
E:	dokument med tidligere prioritet (PL § 2.2.3)	E:	earlier patent document, but published on, or after the filing date
&:	publikasjon i samme patentfamilie	&:	member of the same family

Rapport utferdiget/date of report: 2000.05.29 av/by Harald Tafjord

09/720084 09/720259

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70) 14

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
Opti45PCT		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/NO00/00157	12/05/2000	12/05/1999
International Patent Classification (IPC) or national classification and IPC G03F7/00		
Applicant THINFILM ELECTRONICS ASA et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
12/12/2000	05.04.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Randez Garcia, F Telephone No. +49 89 2399 2234

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/NO00/00157

I. Basis of th r p rt

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-12 as originally filed

Claims, No.:

1-25 as originally filed

Drawings, sheets:

1/1 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-25
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-25
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-25
	No:	Claims	

2. Citations and explanations
   see separate sheet

R It m V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1). The documents cited in the Search Report do not disclose patterning polymers on material surfaces.

2). Thus, US-A-5512131 discloses a process wherein a chemical species capable of forming a self-assembled monolayer is coated onto the stamping surface of an elastomeric stamp, said species having a functional group selected to bind to a particular material. The stamping surface is placed against a surface of a material surface and removed to leave a self-assembled monolayer of the species according to the stamping surface pattern of the stamp. See in particular, from col. 5, line 60, to col. 6, line 14, and fig. 1. This document does not suggest that a polymeric species could be used as the chemical species capable of forming a self-assembled monolayer (see col. 12, lines 10-53).

3). Therefore, the methods of claims 1, 14 and 25 for patterning a polymer film on a material surface cannot be anticipated or rendered obvious by the documents considered.

4). Claims 2-13 on the one hand, and 15-24 on the other hand, relate to modifications of the new and inventive subject-matter disclosed in claims 1 and 14, respectively. Therefore, claims 1-25 meet the requirements of Article 33(2) and (3) PCT.

KOPI til orientering

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No. PCT/NO 00 00157

International Filing Date 12 MAI 2000 (12.05.00)

PATENTSTYRET

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* Opti45PCT

Box No. I TITLE OF INVENTION

Methods for patterning polymer films, and use of the methods

Box No. II APPLICANT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

THIN FILM ELECTRONICS ASA
P.O.Box 1872 Vika
N-0124 Oslo
Norway

☐ This person is also inventor.

Telephone No. +47 23 23 84 40

Facsimile No. +47 23 23 84 41

Teleprinter No.

State *(that is, country)* of nationality: NO

State *(that is, country)* of residence: NO

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

INGANÄS, Olle
Wenersgatan 13
S-582 46 LINKÖPING
SWEDEN

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: SE

State *(that is, country)* of residence: SE

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

LEISTAD, Geirr I. of
THIN FILM ELECTRONICS ASA
P.O.Box 1872 Vika
N-0124 Oslo
Norway

Telephone No. + 47 23 23 84 40

Facsimile No. + 47 23 23 84 41

Teleprinter No.

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

NYBERG, Tobias
Solrosgatan 4A
S-582 46 LINKÖPING
Sweden

This person is:
- [ ] applicant only
- [X] applicant and inventor
- [ ] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: SE

State *(that is, country)* of residence: SE

This person is applicant for the purposes of:
- [ ] all designated States
- [ ] all designated States except the United States of America
- [X] the United States of America only
- [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

GRANLUND, Tomas
Arrendegatan 23
S-583 31 LINKÖPING
Sweden

This person is:
- [ ] applicant only
- [X] applicant and inventor
- [ ] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: SE

State *(that is, country)* of residence: SE

This person is applicant for the purposes of:
- [ ] all designated States
- [ ] all designated States except the United States of America
- [X] the United States of America only
- [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- [ ] applicant only
- [ ] applicant and inventor
- [ ] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of:
- [ ] all designated States
- [ ] all designated States except the United States of America
- [ ] the United States of America only
- [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- [ ] applicant only
- [ ] applicant and inventor
- [ ] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of:
- [ ] all designated States
- [ ] all designated States except the United States of America
- [ ] the United States of America only
- [ ] the States indicated in the Supplemental Box

- [ ] Further applicants and/or (further) inventors are indicated on another continuation sheet.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked)*:

Regional Patent

☒ AP ARIPO Patent: GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SL Sierra Leone, SZ Swaziland, TZ United Republic of Tanzania, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT

☒ EA Eurasian Patent: AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT

☒ EP European Patent: AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT

☒ OA OAPI Patent: BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* .....

National Patent *(if other kind of protection or treatment desired, specify on dotted line)*:

☒ AE United Arab Emirates
☒ AL Albania
☒ AM Armenia
☒ AT Austria
☒ AU Australia
☒ AZ Azerbaijan
☒ BA Bosnia and Herzegovina
☒ BB Barbados
☒ BG Bulgaria
☒ BR Brazil
☒ BY Belarus
☒ CA Canada
☒ CH and LI Switzerland and Liechtenstein
☒ CN China
☒ CR Costa Rica
☒ CU Cuba
☒ CZ Czech Republic
☒ DE Germany
☒ DK Denmark
☒ DM Dominica
☒ EE Estonia
☒ ES Spain
☒ FI Finland
☒ GB United Kingdom
☒ GD Grenada
☒ GE Georgia
☐ GH Ghana
☐ GM Gambia
☒ HR Croatia
☒ HU Hungary
☒ ID Indonesia
☒ IL Israel
☒ IN India
☒ IS Iceland
☒ JP Japan
☒ KE Kenya
☒ KG Kyrgyzstan
☒ KP Democratic People's Republic of Korea
☒ KR Republic of Korea
☒ KZ Kazakhstan
☒ LC Saint Lucia
☒ LK Sri Lanka
☒ LR Liberia
☒ LS Lesotho
☒ LT Lithuania
☒ LU Luxembourg
☒ LV Latvia
☒ MA Morocco
☒ MD Republic of Moldova
☒ MG Madagascar
☒ MK The former Yugoslav Republic of Macedonia
☒ MN Mongolia
☒ MW Malawi
☒ MX Mexico
☒ NO Norway
☒ NZ New Zealand
☒ PL Poland
☒ PT Portugal
☒ RO Romania
☒ RU Russian Federation
☒ SD Sudan
☒ SE Sweden
☒ SG Singapore
☒ SI Slovenia
☒ SK Slovakia
☒ SL Sierra Leone
☒ TJ Tajikistan
☒ TM Turkmenistan
☒ TR Turkey
☒ TT Trinidad and Tobago
☒ TZ United Republic of Tanzania
☒ UA Ukraine
☒ UG Uganda
☒ US United States of America
☒ UZ Uzbekistan
☒ VN Viet Nam
☒ YU Yugoslavia
☒ ZA South Africa
☒ ZW Zimbabwe

Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet:

☒ DZ Algeria
☐

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)*

Box No. VI PRIORITY CLAIM ☐ Further priority claims are indicated in the Supplemental Box.

	Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is: national application: country	regional application:* regional Office	international application: receiving Office
item (1)	12 May 1999 (12.05.99)	1999 2295	NO		
item (2)					
item (3)					

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office)* identified above as item(s): (1)

** Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.*

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):*

ISA/ SE

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority):*

Date *(day/month/year)* Number Country *(or regional Office)*

Box No. VIII CHECK LIST; LANGUAGE OF FILING

This international application contains the following **number of sheets:**

request	:	4
description (excluding sequence listing part)	:	12
claims	:	3
abstract	:	1
drawings	:	1
sequence listing part of description	:	
Total number of sheets	:	21

This international application is **accompanied** by the item(s) marked below:

1. ☒ fee calculation sheet
2. ☐ separate signed power of attorney
3. ☐ copy of general power of attorney; reference number, if any:
4. ☐ statement explaining lack of signature
5. ☐ priority document(s) identified in Box No. VI as item(s):
6. ☐ translation of international application into (language):
7. ☐ separate indications concerning deposited microorganism or other biological material
8. ☐ nucleotide and/or amino acid sequence listing in computer readable form
9. ☐ other *(specify)*:

Figure of the drawings which should accompany the abstract:

Language of filing of the international application: English

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

THIN FILM ELECTRONICS ASA

Geirr I. Leistad
IPR & Legal Department Manager

For receiving Office use only

1. Date of actual receipt of the purported international application: 12 MAI 2000 (12.05.00)
2. Drawings: ☒ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority (if two or more are competent): ISA/SE
6. ☐ Transmittal of search copy delayed until search fee is paid.

For International Bureau use only

Date of receipt of the record copy by the International Bureau:

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF RECEIPT OF RECORD COPY

(PCT Rule 24.2(a))

To:

LEISTAD, Geirr, I.
Thin Film Electronics ASA
P.O. Box 1872 Vika
N-0124 Oslo
NORVÈGE

Date of mailing (day/month/year)	IMPORTANT NOTIFICATION
26 June 2000 (26.06.00)	
Applicant's or agent's file reference	**International application No.**
Opti45PCT	PCT/NO00/00157

The applicant is hereby notified that the International Bureau has received the record copy of the international application as detailed below.

Name(s) of the applicant(s) and State(s) for which they are applicants:

THIN FILM ELECTRONICS ASA (for all designated States except US)
INGANÄS, Olle et al (for US)

International filing date	:	12 May 2000 (12.05.00)
Priority date(s) claimed	:	12 May 1999 (12.05.99)
Date of receipt of the record copy by the International Bureau	:	31 May 2000 (31.05.00)
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ATTENTION

The applicant should carefully check the data appearing in this Notification. In case of any discrepancy between these data and the indications in the international application, the applicant should immediately inform the International Bureau.

In addition, the applicant's attention is drawn to the information contained in the Annex, relating to:

- [X] time limits for entry into the national phase
- [X] confirmation of precautionary designations
- [ ] requirements regarding priority documents

A copy of this Notification is being sent to the receiving Office and to the International Searching Authority.

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer: Aino Metcalfe
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PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

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NOTIFICATION CONCERNING SUBMISSION OR TRANSMITTAL OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

LEISTAD, Geirr, I.
Thin Film Electronics ASA
P.O. Box 1872 Vika
N-0124 Oslo
NORVÈGE

Date of mailing (day/month/year) 26 June 2000 (26.06.00)	
Applicant's or agent's file reference Opti45PCT	**IMPORTANT NOTIFICATION**
International application No. PCT/NO00/00157	International filing date (day/month/year) 12 May 2000 (12.05.00)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 12 May 1999 (12.05.99)
Applicant THIN FILM ELECTRONICS ASA et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).

2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.

3. An **asterisk(*)** appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

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Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
12 May 1999 (12.05.99)	19992295	NO	31 May 2000 (31.05.00)

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Form PCT/IB/304 (July 1998)

WO 00/70406
PCT/NO00/00157

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

To:
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NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

Date of mailing (day/month/year) 23 November 2000 (23.11.00)	
Applicant's or agent's file reference Opti45PCT	**IMPORTANT NOTICE**

International application No.	**International filing date** (day/month/year)	**Priority date** (day/month/year)
PCT/NO00/00157	12 May 2000 (12.05.00)	12 May 1999 (12.05.99)

Applicant
THIN FILM ELECTRONICS ASA et al

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
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   In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

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   The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on
   23 November 2000 (23.11.00) under No. WO 00/70406

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, **a demand for international preliminary examination** must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

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Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

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If the applicant wishes to proceed with the international application in the **national phase**, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer J. Zahra
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International Bureau

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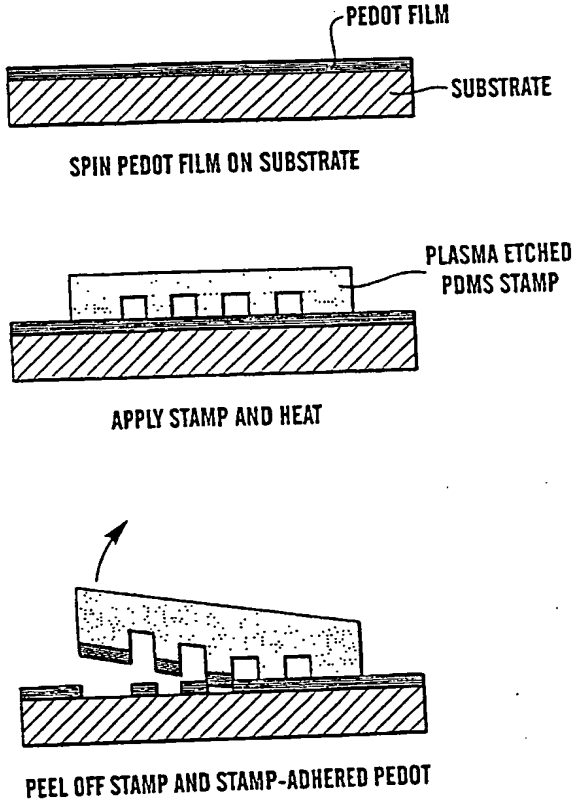
(54) Title: METHODS FOR PATTERNING POLYMER FILMS, AND USE OF THE METHODS

(57) Abstract

In a method for patterning a polymer film forming a coating on a material surface, a thin film of polymer is deposited on the surface and the patterning takes place by applying to the material surface a stamp made of an elastomeric material in conformal contact with the surface of the thin film, such that portions thereof contacting one or more protruding elements of the elastomeric stamp formed by one or more indentations thereof, are attached to the protruding element or elements and removed from the material surface with the stamp. In a method for transferring a patterned polymer film onto a material surface, a thin film polymer is deposited on a stamp surface and the stamp is applied in conformal contact with the material surface, such that thin film of polymer is transferred thereto from one or more protruding elements of the elastomeric stamp formed by at least one indentation thereof, thus leaving a patterned thin film of polymer on the material surface when removing the stamp therefrom. Use for patterning an etched resist in the form of a thin film of polymer on a gold layer.



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Methods for patterning polymer films, and use of the methods

The present invention concerns a method for patterning a polymer film forming a coating on a material surface, wherein the patterning takes place by means of a stamp having a surface with at least one indentation formed therein, and a method for transferring a patterned polymer film onto a material surface by means of a stamp having a surface with at least one indentation formed therein. The invention also concerns the use of methods of this kind.

The use of conjugated polymers in electronic devices requires means for processing them into patternable thin films. Patterning conducting electrodes and semiconducting polymers in polymer diodes requires patterning of all materials, at a resolution of 0.1-50 μm. This can possibly be accomplished by the use of classical photolithography with help of photoresists, but several new problems arise in the chemical etching of the material and the chemical compatibility with conventional photoresists. It would therefore be desirable to pattern this material with non-photolithographic techniques.

A new method for patterning is based on elastomeric stamps. Patterning of a surface here requires conformal contact between the stamp and surface. Many variants of these techniques are documented, in particular in the work from G. Whitesides' group at Harvard University (Y. Xia and G. Whitesides, Soft lithography, Angewandte Chemie-International Edition in English 37(5): 551-575 (1998) and Y. Xia and G. Whitesides, Soft lithography, Annual Review of Materials Science, 28:153-184 (1998)).

The work of Whitesides' group is disclosed in US patent No. 5 512 131, titled "Formation of microstamped patterns on surfaces and derivative articles" (Kumar & Whitesides). This prior art document discloses a method of patterning a material surface, comprising steps of providing a stamp having a surface including at least one indentation formed therein, said indentation configured with a stamping surface defining a first pattern; coating said stamping surface with a molecular species terminating at the first end in a functional group selected to bind to said material; processing said stamping surface in a first orientation and contacting a portion of said material surface with said stamping surface to hold said molecular species against said material surface portion to allow said functional group to bind thereto; and removing said stamping surface to provide a self-assembled

molecular species on said material surface according to said first pattern in said first orientation.

This prior art disclosure amounts to a process wherein a chemical species capable of forming a self-assembled monolayer is coated onto the stamping surface of an elastomeric stamp, said species having a functional group selected to bind to a particular material. The stamping surface is placed against a surface of a material surface and removed to leave a self-assembled monolayer of the species according to the stamping surface pattern of the stamp.

Further there is known a number of different prior art techniques for patterning surfaces or materials deposited thereon without having to resort to conventional photolithography.

As a further example of prior art a paper by Zhang, L.G.; Liu, J.F. and Lu, Z.H., titled "Microfabrication on polymer with a contact procedure", Supramolecular Science, Vol. 5, Nos. 5-6:713-715 (Oct-Dec. 1998) discloses the fabrication of thickness-contrast micropatterns based on a contact procedure. Polymer (polydimethylsiloxane) micropost arrays are fabricated with grids as the masters. This contact procedure, which does not rely on etching, extends the present limits of microfabrication. In addition the thickness-contrast micropatterns on the polymer can be replicated to other substrates, such as silicon wafers, with microcontact printing.

These techniques that are collected in the catchall term soft lithography are based on pattern transfer by a soft rubber stamp in direct contact with the surfaces and materials to be patterned. Soft lithography includes microcontact printing (μCP), replica molding (REM) and micromolding in capillaries (MIMIC). The patterning technique is based on physical contact, not the projection of light through a mask, as in photolithography. The fundamental limits to resolution are due to the range of the van der Waals forces determining the interaction of surfaces (~10 nm), not the diffraction of light in far-field geometries (~0.5 μm).

An important element of microcontact printing (μCP) is the formation, by selfassembly, of a monomolecular layer of etch resistant organic molecules. Alkanethiols are the preferred species, which chemisorb into molecular thin films on Au, Ag, Cu and other metal surfaces. They form layers of very small

thickness (1-3 nm) which are tightly bound (but can be desorbed at high temperatures and by exchange). These alkane layers are used as the resist; a metal layer is protected from etching below the molecular film, and where it is not deposited the metal is removed. The patterning of the resist layer is in its turn done with molecular stamps. A poly(dimethylsiloxane) (PDMS) layer, patterned with protruding and recessed elements in a prior step, is exposed to a solution of alkanethiols; the rubbery stamps are pressed onto a surface for a short time; alkanethiols react with the gold surface when close contact is obtained; and a pattern of protected and non-protected Au is obtained. This layer is now exposed to another alkanethiol, adsorbing from solution onto the unprotected gold surface. A patterned layer is obtained. The process is called microcontact printing (μCP). It has been established that formation of the patterned structure occurs within a few seconds.

The patterned layer may now be used as ultrathin resists in selective wet etching, or as templates for the control of wetting, dewetting, nucleation and growth or deposition of other materials. Minimal sizes of 35 nm trenches in Au layers have been obtained with etching techniques.

Patterned self-assembled monolayers (SAMs) allow control of the local hydrophobic/hydrophilic nature of the surface, and therefore act to control the deposition of materials. Water will condense on the hydrophilic part of the surface; this allows us to deposit materials from water solution onto a patterned surface in a regular fashion. Likewise, organic polymers may be deposited onto the hydrophobic surfaces from organic solvents. Both these approaches allow the formation of patterned structures of deposited material. Selective chemical vapour deposition (CVD) processes onto SAMs controlling the nucleation behaviour is another approach for pattern formation in ceramics and metals. Proteins and cells can be selectively adsorbed on patterned surfaces.

It is easy to pattern non-planar surfaces with this approach, a near impossibility with photolithography. Capillaries of radius of curvature 50 μm have been patterned with structures of dimensions down to a few microns. This enables the construction of more complex structures on patterned and non-planar surfaces, relieving one of the tyranny of planar photolithography.

The microcontact printing is simple, inexpensive and flexible. With bigger structures (>20 μm) clean room facilities are not necessary. The stamp can be

used and reused many times, providing high fidelity reproduction. Because the master structure is normally used as a template to prepare "negatives" (as it were), one can form many identical stamps from a single master, and each one of them can be used some hundred times - multiple copying and parallel processing of the structures is therefore possible. The capital cost of producing the structures is very low. The fabrication of masters of course requires other lithographical techniques, such as photolithography or electron beam lithography, but the multiplication of stamps gives parallel production lines. Micromolding is a small twist to classical molding in that a soft and flexible silicone rubber is used, rather than a hard mold. The elasticity and low surface energy of this mold material allows it to be removed easily from the prepared structure. Replica-molding (REM) can be obtained down to the 30 nm dimensions. Such methods may be used to prepare optical structures as in gratings, microlenses, Fresnel lenses and similar designs for the diffraction and refraction of light. Microprinting is best obtained with the technique named micro-transfer molding (μTM) where a patterned mold is filled with a liquid prepolymer, excess liquid removed and the mold pressed against a surface, irradiated or heated to polymerize. After the liquid precursor is converted into a solid, the mold is peeled away. In a slight modification of this technique (micromolding in capillaries, MIMIC) connected structures are placed in contact with low viscosity liquids, which fill the channels by capillary action. These liquids may carry nanoparticles, or solutions for solgel conversion, or polymers in solution. After conversion of the liquid to a solid, the mold is removed. Processing of the resulting structure by photochemistry or thermal treatment is now possible, for instance converting a precursor to carbon materials. The remaining structure may now be the functional element - such as an optical waveguide - or a resist to be used to etch the underlying material. In a slight twist to this method, SAMIM (solvent assisted MIMIC), a solvent is used to modify the sample surface to be patterned, and the patterned is defined with a micromold in which the structure is defined.

The very important aspect of faithful reproduction over large areas and with low defect density is not yet fully resolved. In a recent report from IBM Zurich, it is claimed that structures of 1 micrometer pitch were faithfully replicated without defects over areas of 10 cm^2, using μCP or MIMIC.

Patterning of monolayers of molecules is the most elegant and novel of these prior art methods, but is limited to transfer of monolayers, subsequently used for etch resists and surface activating elements. Transfer of polymer patterns is normally done with MIMIC and microcontact printing. In MIMIC a polymer precursor is patterned by filling channels defined by applying a stamp onto a surface; in microcontact printing a polymer (precursor) fills the channels turned upside down, in such a way as to form the structure which is then transferred to the surface. Transfer of polymer layers to functionally modified surfaces has been reported; see L. Yan, W.T.S. Huck, X.M. Zhao, and G.M. Whitesides, Patterning thin films of poly(ethylene imine) on a reactive SAM using microcontact printing, Langmuir, 15(4): 1208-1214 (1999).

The patterning of polymers, and in particular conjugated polymers has been reported (see Z. Huang, P.C. Wang, J. Feng, A.G. MacDiarmid, Y. Xia, and G.M. Whitesides, Selective deposition of films of polypyrrole, polyaniline and nickel on hydrophobic/hydrophilic patterned surfaces and applications, Synthetic Metals, 85(1-3):1375-1376 (1997); and Z.Y. Huang, P.C. Wang, A.G. MacDiarmid, Y.N. Xia, and G. Whitesides, Selective deposition of conducting polymers on hydroxyl-terminated surfaces with printed monolayers of alkylsiloxanes as templates, Langmuir 13(24):6480-6484 (1997)) using hydrophobic/hydrophilic modification of monomer adhesion. It may be difficult to deposit high quality polymers from dispersions and solutions with the materials used in these stamps; in particular, the swelling of a poly(dimethylsiloxane) stamp in chloroform prevents the patterning of many of the luminescent polymers used for electroluminescent polymer displays where patterning is desired. These polymers are often solvated in solvents such as chloroform. Likewise, the patterning of water-soluble polymers prohibits the use of some soft lithography techniques, such as MIMIC (Y. Xia and G. Whitesides, Soft lithography, Angewandte Chemie-International Edition in English 37(5): 551-575 (1998) and Y. Xia and G. Whitesides, Soft lithography, Annual Review of Materials Science, 28:153-184 (1998)) as the solvent is required to pass through an elastomeric membrane. Chloroform will swell the stamp, and destroy the fine pattern to be transferred; in the other extreme, water is not easily transported through the extremely non-polar elastomeric stamp, and pattern transfer will be prohibited. Novel patterning methods are therefore desired.

In regard of certain drawbacks and limitations of the above-mentioned prior art methods, it is thus an object of the present invention to provide methods whereby patterns can be generated in thin films of polymer deposited on material surface by a simple and inexpensive technique based on the use of a specially designed stamp for generating the patterns. Particularly it is another object of the present invention to be able to pattern thin film of polymers which initially form continuous layers and moreover exhibit advantageous electronic or optical properties, e.g. for use as pattern electrodes or pixels in optoelectronic displays.

Finally, it is also an object of the invention to provide patterned thin films of polymer on a substrate in order to facilitate specific processing of the substrate.

The above-mentioned objects and advantages are realized with a method for patterning a polymer film according to the invention the method being characterized by depositing onto the material surface a thin film of polymer, applying to the material surface the stamp made of an elastomeric material in conformal contact with the surface of the thin film, such that portions thereof contacting one or more protruding elements of the elastomeric stamp, the formed by the at least one indentation thereof, are attached to the protruding element or elements and removed from the material surface with the stamp.

According to the invention the polymer can advantageously be modified by incorporating additives in order to reduce the cohesive binding of the polymer film, in which case an additive can be a water-soluble organic compound, or selected among ethylene glycol, poly(ethylene glycol), glycerol, sorbitol, polyol, or any combinations thereof.

According to the invention the polymer can be a water-soluble or dispersed polymer, or a conducting conjugated polymer in its doped or undoped state, or poly(3,4-dioxyethylenethiophene) (PEDOT) or deriving from a copolymer thereof, or one or more mixtures incorporating the monomer (EDOT) form.

According to the invention it is advantageous modifying the material surface in order to provide a weak adhesion between the material surface and the polymer film to be removed therefrom, and then preferably modifying the material surface by plasma etching.

According to the invention it is also advantageous modifying the elastomer stamp surface in order to provide a strong adhesion between the stamp and the polymer film to be attached thereto, and then preferably modifying the elastomer stamp surface by plasma etching.

Finally it is according to the method of the invention advantageous enhancing the adhesion between stamp and polymer film by means of additives to the latter, an additive then preferably being glycerol.

The above-mentioned object and advantages are also realized according to the present invention with a method for transferring a polymer film, the method being characterized by depositing onto the stamp surface a thin film of polymer, applying the stamp made of an elastomeric material in conformal contact with the material surface, such that the thin film of polymer is transferred thereto from one or more protruding elements of the elastomeric stamp formed by the at least one indentation thereof, and leaving a patterned thin film of polymer on the material surface when removing the stamp therefrom.

In the above method according to the invention it is advantageous modifying the polymer film by incorporating additives in order to reduce the cohesive binding of the polymer film, the additive then preferably being a water-soluble organic compound, or preferably selected an additive among ethylene glycol, poly(ethylene glycol), glycerol, sorbitol, polyol, or any combinations thereof.

In the above method according to the invention it is advantageous that the polymer film is a water-soluble or dispersed polymer, or that the polymer is a conducting conjugated polymer in its doped or undoped state, or poly(3,4-dioxyethylenethiophene) (PEDOT) or deriving from a copolymer thereof, or one or more mixtures incorporating the monomer (EDOT).

In the above method according to the invention it is advantageous modifying the elastomer stamp surface in order to provide a weak adhesion between the elastomer surface and the polymer film to be removed therefrom, and then preferably modifying the elastomer stamp surface by plasma etching.

In the above method according to the invention it is advantageous modifying the material surface in order to provide a strong adhesion between the

material surface and the polymer film to be transferred thereto, and then preferably modifying the material surface by plasma etching.

Finally the above mentioned objects and advantages are provided with the use of the method for patterning or the method for transferring to provide a patterned etch resist in the form of a thin film of polymer on a gold layer, whereby the gold layer can be removed by etching of the area unprotected by the resist, the polymer preferably being PEDOT.

Further features and advantages of the method according to the invention are apparent from the appended dependent claims.

The invention shall now be described in a general manner and in connection with the appended drawing figures in case of one of the methods, as well as with a reference to exemplary embodiments of both the methods.

In the drawing figures,

fig. 1 shows the deposition of a thin film of polymer on a substrate,

fig. 2 the application of a stamp to the thin film polymer, and

fig. 3 schematically the patterning of the thin film of the polymer.

A particular polymer of great interest in these devices is the poly(3,4-dioxoethylenethiophene) (PEDOT) which is a commercial polymer from Bayer AG. It is produced in the form of an aqueous dispersion, and can be coated, e.g. spin-coated onto a surface to form a thin film. This film has very attractive properties for polymer electronic devices as it for instance enhances the stability and efficiency of polymer light emitting diodes, or the hole collection in polymer photodiodes, or the hole injection in metal/PEDOT/polymer structures. It is, however, difficult to pattern this polymer dispersion with the hydrophobic polydimethylsiloxane (PDMS) stamp in the MIMIC method. Thus the present invention provides alternative methods of patterning PEDOT films.

One of the requirements for the use of this patterned film is that sufficient electrical conductivity can be obtained to allow the polymer to be used as the electrode in devices. Surprisingly, the patternable film is obtained with similar additives which has been shown to give enhanced electrical conductivity, up to 80 S/cm, after thermal curing.

In these methods according to the present invention, a film of modified PEDOT is deposited on the surface to be patterned by spin coating, and patterning is done by removing parts of the film with a suitable elastomer stamp. This is the first method according to the invention and shall subsequently be termed "Lift-up". In the alternative method, a modified PEDOT layer is deposited on the stamp and then transferred onto the surface to be patterned. This is the second method according to the invention and subsequently termed "Put-down".

These methods are superior to prior art in that they allow patterning of very large areas on (non-planar) surfaces. It is documented in the literature (see Y. Xia and G. Whitesides, Soft lithography, Angewandte Chemie-International Edition in English 37(5): 551-575 (1998); and Y. Xia and G. Whitesides, Soft lithography, Annual Review of Materials Science, 28:153-184 (1998)) that polymers can be deposited onto surfaces in patterns with MIMIC, in which indentations in a stamp act as channels to allow capillary filling with some polymer solution or precursor polymer. This requires that all areas to be filled are connected; an isolated pixel cannot be filled by capillary action. MIMIC will also require long filling time, as the size of channels is reduced and length increased. It is therefore not suited for reel-to-reel production. Both the methods according to the invention are in principle compatible with reel-to-reel production, and also allow the patterning of isolated structures.

They are also superior in that the patterning of the polymer layer does not (necessarily) require the previous patterning of the surface, as for instance in Z. Huang, P.C. Wang, J. Feng, A.G. MacDiarmid, Y. Xia, and G.M. Whitesides, Selective deposition of films of polypyrrole, polyaniline and nickel on hydrophobic/hydrophilic patterned surfaces and applications, Synthetic Metals, 85(1-3):1375-1376 (1997); and Z.Y. Huang, P.C. Wang, A.G. MacDiarmid, Y.N. Xia, and G. Whitesides, Selective deposition of conducting polymers on hydroxyl-terminated surfaces with printed monolayers of alkylsiloxanes as templates, Langmuir 13(24):6480-6484 (1997), and that polymers, not monomers, are deposited.

The preparation of the modified polymer is done in order to tune the cohesive energy of the film, which has to allow the rupturing of the film in both methods; it is also done to tune adhesion to the substrate and/or stamp. The

internal cohesion of the film is modified by adding low molecular species in the present case, but could in general be any additive giving this function. It is, of course, essential that the additives are in no way detrimental to the function of the layer, and in the present case the additives are actually beneficial to the function.

When considering the advantages of these methods, we note that Lift-up and Put-down are complementary in the sense that where the former fails, the latter should work. Poor adhesion of the film to be patterned to the substrate suggests that Lift-up should be used; poor adhesion to the stamp suggests that Put-down could be used.

In Lift-up, the polymer film transfer between stamp and surface is used to pick up parts of a PEDOT film from a substrate, by attaching an elastomeric stamp onto the thin film of PEDOT on a fully covered substrate. The molecular contact between film and stamp breaks up the film, and it can now be micropatterned to any topology by this method. The PEDOT film will also now be prepared with the help of additives, and after transfer the film is cured/converted to a higher conductivity by thermal treatment. Features of dimensions down to 10 μm can easily be patterned. One of the advantages of this technique as compared to MIMIC is that isolated PEDOT pixel can be defined. In this method no solvent is used, which increases the number of materials that can be patterned.

Specifically fig. 1 relates to the lift-up and shows how a PEDOT film is spin deposited on the substrate. In a second step shown in fig. 2 a plasma etched poly(dimethylsiloxane) stamp is applied to the thin film and simultaneously heated. The stamp may be plasma etched to obtain an adhesion between the thin film and the stamp which is stronger than the adhesion between the thin film and the substrate. In the subsequent and final step in the Lift-up process, shown in fig. 3, the stamp is lifted and the thin-film polymer in the form of PEDOT adheres to the protruding portion of the stamps, such that the pattern is formed in the thin film PEDOT on the substrate when the stamp is removed.

In Put-down a slightly modified PEDOT dispersion is coated onto an elastomeric stamp by spin coating. By adding a low molecular weight compound such as ethylene glycol, glycerol or sorbitol in the dispersion, the surface remains sticky enough to attach to another surface brought close. For

structures with a large enough spacing between the protruding parts this is sufficient to transfer the PEDOT residing on the upper edge of the structure onto a mating surface, at the right temperature and pressure. With the use of the Put-down method one may be able to transfer films with structures smaller than 100 μm. This method has the added advantage that no limitation to the topology is caused from the filling of channels with liquid, such as in the MIMIC process. There is also the advantage that the surface to be coated does not need to be planar; actually non-even surfaces can be handled.

It shall now be examples of particularly preferred embodiments according to the invention, including both the lift-up and the put-down processes.

Example 1: Lift-up

Poly(3,4-dioxymethylenethiophene)-polystyrenesulfonate (PEDOT-PSS) (Baytron from Bayer AG) is mixed with glycerol to make a 1:2 weight ratio mixture. The mixture is spin-coated into a thin continuous layer on a glass surface. An elastomer stamp formed in poly(dimethylsiloxane) (Sylgard 184, Dow Corning) is plasma-treated for 10 to 30 s in an oxygen plasma. The relief-patterned stamp is brought in conformal contact with the layer, which is then heated to 50-100° C for 15 to 60 s and subsequently removed with the removal of the elastomer stamp. – As an alternative to glycerol sorbitol could be used, but apparently sorbitol mixed PEDOT-PSS works poorly if at all with Lift-up.

Example 2: Lift Up

PEDOT-PSS (Baytron from Bayer AG) is mixed with glycerol to make a 1:1 weight ratio mixture. The mixture is spin-coated into a thin continuous layer on a glass surface. An elastomer stamp formed in poly(dimethylsiloxane) (Sylgard 184, Dow Corning) is plasma-treated for 10 to 30 s in an oxygen plasma. The relief-patterned stamp is brought in conformal contact with the layer, which is then heated to 50-100° C for 15 to 60 s and subsequently removed with the removal of the elastomer stamp.

Example 3: Put-down

PEDOT-PSS (Baytron from Bayer AG) is mixed with ethylene glycol to make a 1:1 molar ratio mixture. An elastomer stamp formed in poly(dimethylsiloxane) (Sylgard 184, Dow Corning) is plasma-treated for 10 s in an oxygen plasma. The relief-patterned stamp is dipped into the mixture and dip-coated. It is brought in conformal contact with an ITO

surface and part of the layer is deposited from the stamp onto the ITO, leaving a layer of patterned PEDOT-PSS mixture.

Example 4: Put-down

PEDOT-PSS (Baytron from Bayer AG) is mixed with ethylene glycol to make a 1:1 molar ratio mixture. An elastomer stamp formed in poly(dimethylsiloxane) (Sylgard 184, Dow Corning) is plasma-treated for 10 s in an oxygen plasma. The relief-patterned stamp is dip-coated with the mixture. It is brought in conformal contact with an Au surface and part of the layer is deposited from the stamp onto the Au, leaving a layer of patterned PEDOT-PSS mixture.

Example 5: Put-down

PEDOT-PSS (Baytron from Bayer AG) is mixed with glycerol to make a 1:1 molar ratio mixture. An elastomer stamp formed in poly(dimethylsiloxane) (Sylgard 184, Dow Corning) is plasma-treated for 10 s in an oxygen plasma. The relief-patterned stamp is dip-coated with the mixture. It is brought in conformal contact with a Cu surface and part of the layer is deposited from the stamp onto the Cu, leaving a layer of patterned PEDOT-PSS mixture.

Example 6: Put-down

PEDOT-PSS (Baytron from Bayer AG) is mixed with glycerol to make a 1:1 molar ratio mixture. An elastomer stamp formed in poly(dimethylsiloxane) (Sylgard 184, Dow Corning) is plasma-treated for 10 s in an oxygen plasma. The relief-patterned stamp is dip-coated with the mixture. It is brought in conformal contact with a glass surface and part of the layer is deposited from the stamp onto the glass, leaving a layer of patterned PEDOT-PSS mixture.

Example 7: Put-down

PEDOT-PSS (Baytron from Bayer AG) is mixed with glycerol to make a 1:1 molar ratio mixture. An elastomer stamp formed in poly(dimethylsiloxane) (Sylgard 184, Dow Corning) is plasma-treated for 10 s in an oxygen plasma. The relief-patterned stamp is dip-coated with the mixture. It is brought in conformal contact with an Au surface and part of the layer is deposited from the stamp onto the Au, leaving a layer of patterned PEDOT-PSS mixture. The decorated Au surface is exposed to an etchant (gold etch solution: 5g I_2, 10 g KI dissolved in 250 ml H_2O) to remove the unprotected Au layer.

PATENT CLAIMS

1. A method for patterning a polymer film forming a coating on a material surface, wherein the patterning takes place by means of a stamp having a surface with at least one indentation formed therein, characterized by depositing onto the material surface a thin film of polymer, applying to the material surface the stamp made of an elastomeric material in conformal contact with the surface of the thin film, such that portions thereof contacting one or more protruding elements of the elastomeric stamp formed by the at least one indentation thereof are attached to the protruding element or elements and removed from the material surface with the stamp.

2. A method according to claim 1, characterized by modifying the polymer film by incorporating additives in order to reduce the cohesive binding of the polymer film.

3. A method according to claim 2, characterized by an additive being a water-soluble organic compound.

4. A method according to claim 2, characterized by an additive being selected among ethylene glycol, poly(ethylene glycol), glycerol, sorbitol, polyol, or any combinations thereof.

5. A method according to claim 1, characterized by the polymer being a water-soluble or dispersed polymer.

6. A method according to claim 1, characterized by the polymer being a conducting conjugated polymer in its doped or undoped state.

7. A method according to claim 1, characterized by the polymer being poly(3,4-dioxyethylenethiophene) (PEDOT) or deriving from a copolymer thereof or one or more mixtures incorporating the monomer (EDOT) form.

8. A method according to claim 1, characterized by modifying the material surface in order to provide a weak adhesion between the material surface and the polymer film to be removed therefrom.

9. A method, according to claim 8, characterized by modifying the material surface by plasma etching.

10. A method according to claim 1, characterized by modifying the elastomer stamp surface in order to provide a strong adhesion between the stamp and the polymer film to be attached thereto.

11. A method according to claim 9, characterized by modifying the elastomer stamp surface by plasma etching.

12. A method according to claim 1, characterized by enhancing the adhesion between stamp and the polymer film by means of additives to the latter.

13. A method according to claim 12, characterized by an additive being glycerol.

14. A method for transferring a patterned polymer film onto a material surface by means of a stamp having a surface with at least one indentation formed therein, characterized by depositing onto the stamp surface a thin film of polymer, applying the stamp made of an elastomeric material in conformal contact with the material surface, such that the thin film of polymer is transferred thereto from one or more protruding elements of the elastomeric stamp formed by the at least one indentation thereof, and leaving a patterned thin film of polymer on the material surface when removing the stamp therefrom.

15. A method according to claim 14, characterized by modifying the polymer film by incorporating additives in order to reduce the cohesive binding of the polymer film.

16. A method according to claim 15 , characterized by an additive being a water soluble organic compound.

17. A method according to claim 15, characterized by an additive being selected among ethylene glycol, poly(ethylene glycol), glycerol, sorbitol, polyol, or any combinations thereof.

18. A method according to claim 14, characterized by the polymer being a water-soluble or dispersed polymer.

19. A method according to claim 14, characterized by the polymer being a conducting conjugated polymer in its doped or undoped state.

20. A method according to claim 14, characterized by the polymer being poly(3,4-dioxyethylenethiophene) (PEDOT) or deriving from a copolymer thereof or one or more mixtures incorporating the monomer (EDOT).

21. A method according to claim 14, characterized by modifying the elastomer stamp surface in order to provide a weak adhesion between the elastomer surface and the polymer film to be removed therefrom.

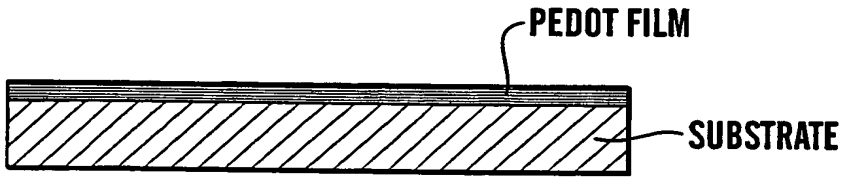
22. A method according to claim 21, characterized by modifying the elastomer stamp surface by plasma etching.

23. A method according to claim 14, characterized by modifying the material surface in order to provide a strong adhesion between the material surface and the polymer film to be transferred thereto.

24. A method according to claim 23, characterized by modifying the material surface by plasma etching.

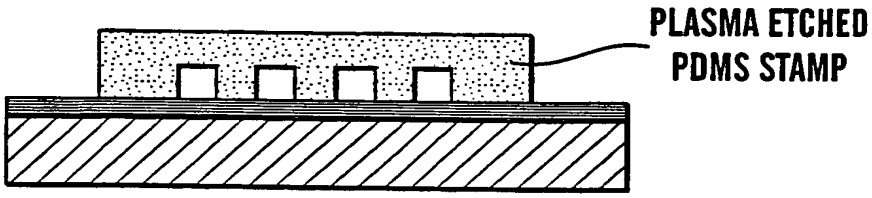
25. The use of a method according to claims 1 or 14 to provide a patterned etch resist in the form of a thin film of polymer on a gold layer, whereby the gold layer can be removed by etching of the area unprotected by the resist, the polymer preferably being PEDOT.

1/1



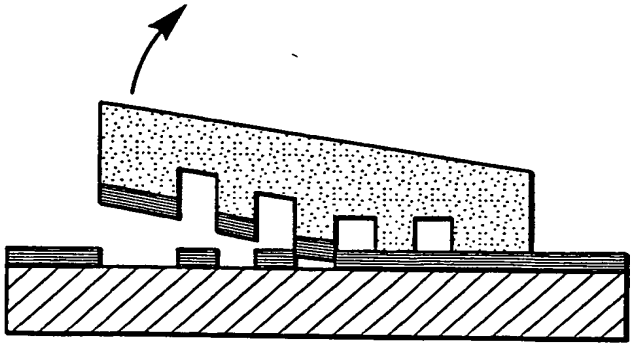
SPIN PEDOT FILM ON SUBSTRATE

Fig. 1



APPLY STAMP AND HEAT

Fig. 2



PEEL OFF STAMP AND STAMP-ADHERED PEDOT

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 00/00157

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G03F 7/00, B41M 1/06, B81C 1/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B41M, B81C, G03F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

QUESTEL: EDOC, WPIL, JAPIO DIALOG: DIALINDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5512131 A (AMIT KUMAR ET AL), 30 April 1996 (30.04.96), column 5, line 62 - column 6, line 14; column 11, line 22 - line 62, figure 1a ---	14-16
A	US 5358604 A (CHARLES W.C. LIN ET AL), 25 October 1994 (25.10.94), column 7, line 11 - column 8, line 9, figures 1-6 --- --------	14-25

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 August 2000	16 -08- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Bengt Christensson/MN Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
NO0000157

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).:

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See next page

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO99/00157

I Claims 1-13 describe a method for patterning a polymer film. A stamp is applied to the polymer. Portions of the polymer film are removed with the stamp.

II Claims 14-25 describe a method for transferring a patterned polymer film onto a material surface by means of a stamp.

The "special technical features" in each group of claims are as a whole different form each other. Therefore, these groups of inventions are not so linked together as to form a single inventive concept with regard to PCT Rule 13.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/NO 00/00157

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5512131 A	30/04/96	US 5900160 A	04/05/99
US 5358604 A	25/10/94	NONE	